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Economical Evaluation of the Impact of some Methods of Rice Stubble Management on Berseem and Rice Yields

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CROP residues management is an important factor in strategic planning due to its role in choosing the proper crop to be grown, subsequent crops in the rotation, the type and amount of fertilizer and pest control required, as well as the production of subsequent crops. Therefore, four treatments of rice stubble management {no-tillage (NT), no-tillage + stubble burning (NT+SB), conventional tillage (CT) and conventional tillage + stubble burning (CT+SB)} were chosen to evalute their impact on the yields of berseem (*Trifolium alexandrinum*) and rice (*Oryza sativa*) crops cultivated in a clayey soil at the Experimental Farm of Tani El-Nataf, Kafr El-Sheikh Governorate, Egypt, in two successive agricultural seasons, *i.e.*, 1996-97 and 1997-98.

The fresh yield of berseem was highly significantly affected by the studied treatments. In comparison with NT treatment, (CT) treatment resulted in 42.2 to 43.4% increases in total fresh yield. Meanwhile, burning treatment (NT+SB) showed a noticeable reduction in total fresh yield of berseem. This reduction ranged between –3.6 to -7.9 % in both seasons.

Results of grain and straw yields of rice indicated that, (CT) treatment achieved 31.2 to 42.1 % and 29.0 to 26.5 % increases for grain and straw yields, in both seasons, respectively. In contrast, burning treatment resulted in –12.2 to –5.6 % decline in grain yield of rice in both seasons, respectively.

The economical evaluation indicated that, conventional tillage (CT) treatment gave the highest profit for both crops (berseem and rice) followed by (CT+SB) treatment. In contrast, the highest lost in the net farm income was recorded under (NT+SB) treatment. in addition to the negative environmental return due to air pollution.

Keywords: Economical evaluation, Profit, Fresh yield, Grain yield.

Residue production by all cereal crops is estimated at 2.5 Pg* for the world. These are undoubtedly large quantities of renewable resources that can be used to enhance soil quality and regulate the environment. Recently, in Egypt the cereal straw (especially, rice straw) production is more than currently required for

agriculture or industrial purposes. So most of this surplus straw is recycled in soil or burnt in the field.

Burning of crop residues and grasslands can reduce soil fertility and crop production. Burning removes vegetative material that would have added humus and nitrogen to the soil, and destroys old vegetation which can increase water-holding capacity of soil, consequently, crop production may decline. Holland & Felton (1989); Papastylianou (1990); Littleboy *et al.* (1992) and Shahin *et al.* (1998).

Tillage and planting practices are the key element in any successful production system. The effect of tillage practice on crop growth and yield was studied by several investigators. Das *et al.* (1987) found that, tillage by discing and moldboard plough produced wheat grain yields of 3.12 and 3.26 t ha^{-1}, respectively, compared with 1.99 t ha-1 with zero-tillage. They believed that tillage increased water depletion by the crop and increased water use efficiency. Also, Edwards *et al.* (1988) and Griffith *et al.* (1988) reported that corn yield with no tillage was 30% lower than those from conventional tillage systems. Furthermore, they found that, soybean yields in strip and no-tillage decreased 16% compared to conventional tillage. In this consept, Hegazy *et al.* (1991) reported that seed yield and straw yield of faba been were significantly increased with tillage comparing with no tillage in both seasons of experimentation.

The present work was carried out to study the reflection of the investigated methods of rice stubble management on soil productivity for berseem and rice crops in the northern part of the Nile Delta.

Material and Methods

A field experiment was conducted at the Experimental Farm of Tani El-Nataf, Sakha Agriculture Research Station, Kafr El-Sheikh Governorate, Egypt. The experiment was carried out in two successive seasons of 1996-97 and 1997-98.

Experimental Design

The investigated field (one feddan*) was divided into sixteen equal homogenous plots. Each plot area was 5 x 32 m (160 m^2). These plots were separated from each other by fireproof tracks (1x32 m). The experimental field was provided with tile drainage system (PVC drains, 50 m spacing and 130 cm depth without gravel envelope materials). A randomized complete block design with four replicates for each treatment was implemented in the experimental area. Figure 1 illustrates the schematic diagram of the whole experimental site.

*Pg = petagram = 10^{15} g.
* 4200 m^2

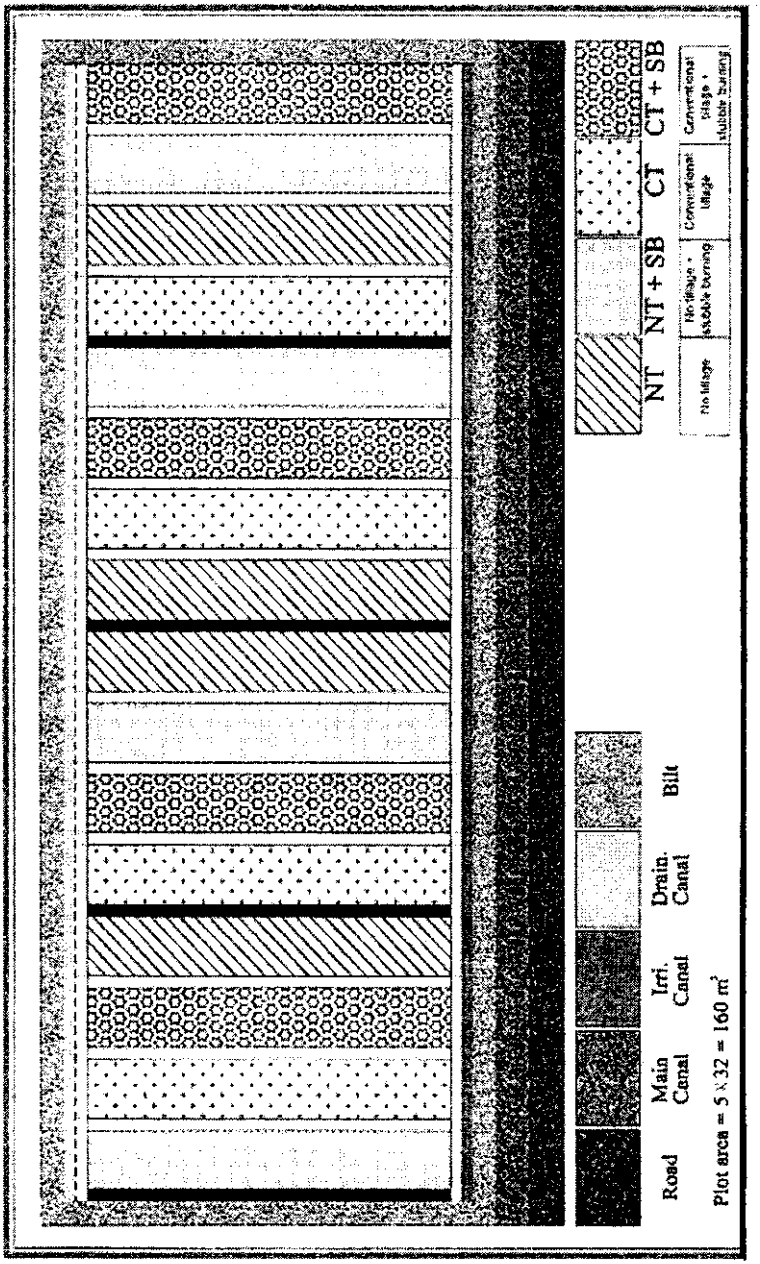

Fig.1. Schematic diagram representing the distribution of the investigated treatments.

The soil characteristics of the experimental site indicated that the soil is classified as clayey, non-saline, non-alkali soil (Table 1).

TABLE 1. Some physical and chemical characteristics of the experimental soil site.

A-Physical characteristics

Soil depth (cm)	Particle size distribution (%)				Texture class	$CaCO_3$ %	O.M %
	C.sand	F.sand	Silt	Clay			
0-20	0.6	13.7	31.0	54.7	Clay	1.72	1.35
20-40	0.5	16.4	28.4	54.7	Clay	1.65	0.84
40-60	0.5	22.9	27.5	49.1	Clay	1.31	0.71

B- Chemical characteristics

Soil Depth (cm)	EC_e (dSm^{-1})*	pH	Soluble Cations (meq/L)				Soluble anions (meq/L)			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
0-20	1.42	7.68	4.15	2.29	8.10	0.30	1.90	3.85	2.20	6.89
20-40	1.51	8.03	4.60	2.78	9.11	0.25	2.30	4.30	2.80	7.34
40-60	1.84	8.04	5.61	2.88	11.00	0.35	2.60	4.21	3.60	9.43

* In soil paste extract.

Treatments

Four treatments of rice stubble management practices were achieved:

1-No tillage (NT) rice stubble was removed and berseem seeds (Egyptian clover) were sown on soil surface directly without any tillage operation.

2-No tillage + rice stubble burning (NT + SB), rice stubble was burned on the surface of soil plots and berseem seeds were sown directly without any tillage operation.

3-Conventional tillage (CT), rice stubble was ploughed into a depth of 30 cm. The conventional tillage consisted of, moldboard plowing to incorporate crop residues, tandem-disking, and harrowing to prepare the seedbed of berseem.

4-Conventional tillage + rice stubble burning (CT + SB), rice stubble was burned on the surface of soil plots and the burnt materials were incorporated into 30 cm depth using moldboard plowing. Different treatments of rice stubble disposal have been done every year at the same plots.

Planting

Upon rice maturity, at the end of summer season of 1996, the experiment was started. Rice plants were combined with a cutter bar 10 cm above ground and the residues were treated as previously mentioned in the experimental plan. All plots were sown with certified berseem seeds (Trifolium alexandrinum, c.v. Sakha 4) at the rate of 32 kg/fed. On December, 2^{nd} (1996) and December, 10^{th} (1997) for the first and second seasons, respectively. On July 1997 and 1998, the experimental plots were prepared for rice cultivation (Oryza sativa c.v. Giza 177). The common agricultural practices were used through the growth seasons of both crops.

Fertilization regimes

Nitrogen fertilizer was banded for rice plants at the rate of 75 kg urea fed^{-1} in two equal splits after one and 4 weeks from trans-planting. Both crops, berseem

and rice, received super-phosphate at the rate of 100 kg fed^{-1} with the preparation of seedbed.

Fresh weight of berseem

Three cuts of berseem were taken, after two, three and four months from sowing. At every cut, berseem plants were mowed at about 3 cm height from soil surface using a sickle. The fresh yield of each plot was weighted directly and calculated as t fed^{-1}.

Grain and straw yields of rice

Rice plants of the entire area for each plot were harvested with a field harvester then, rice grains were weighted to determine the total grain yield in t fed^{-1}. Also, the rice straw that derived from harvesting was weighted to calculate the straw yield in t fed^{-1}.

Statistical analyses

Variance in fresh weight of berseem as well as grain and straw yields of rice between and within treatments of rice stubble management was analyzed u sing the mean values. Sensitivity of each crop yield to variation in the treatments was evaluated using F-value test. Data were interpreted using the least significant difference values (LSD).

Results and Discussion

Data illustrated in Fig. 2 reveal that fresh yield of berseem was significantly increased by the tillage treatments comparing with no-tillage ones. As (CT) treatment resulted in the highest fresh yield, followed by (CT + SB) treatment, meanwhile, the (NT) and (NT + SB) treatments recorded the lowest fresh yields. (CT) and (CT + SB) treatments resulted in 42.2 to 43.4 % and 14.8 to 18.5 % increases in total fresh yield in both investigated seasons, respectively, in comparison with the NT treatment. In contrast, burning treatment (NT + SB) shows a noticeable reduction in total fresh yield of berseem. This reduction ranged between -3.6 to -7.9 % in both seasons.

The same trend was obtained for both grain and straw yields of rice, their values were positively affected by the tillage treatments. However the (CT) one proved to be significantly effective and the (NT + SB) treatment realized the lowest grain and straw yields (Fig. 3).

In comparison of NT treatment results with the other treatments, it is found that the increasing percentages achieved under (CT) treatment were 31.2 to 42.1% and 29.0 to 26.5 for grain and straw yields, in the two seasons under investigation, respectively. Meanwhile, the corresponding values under (CT + SB) treatment ranged between 7.8 to 10.8 and 18.3 to 4.2 %. In contrast, burning treatment resulted in a considerable decline in both yield components. This decline ranged between -12.2 to -5.6 % for grain yield, and between -0.9 to -5.9 % for straw yield, in the two seasons, respectively.

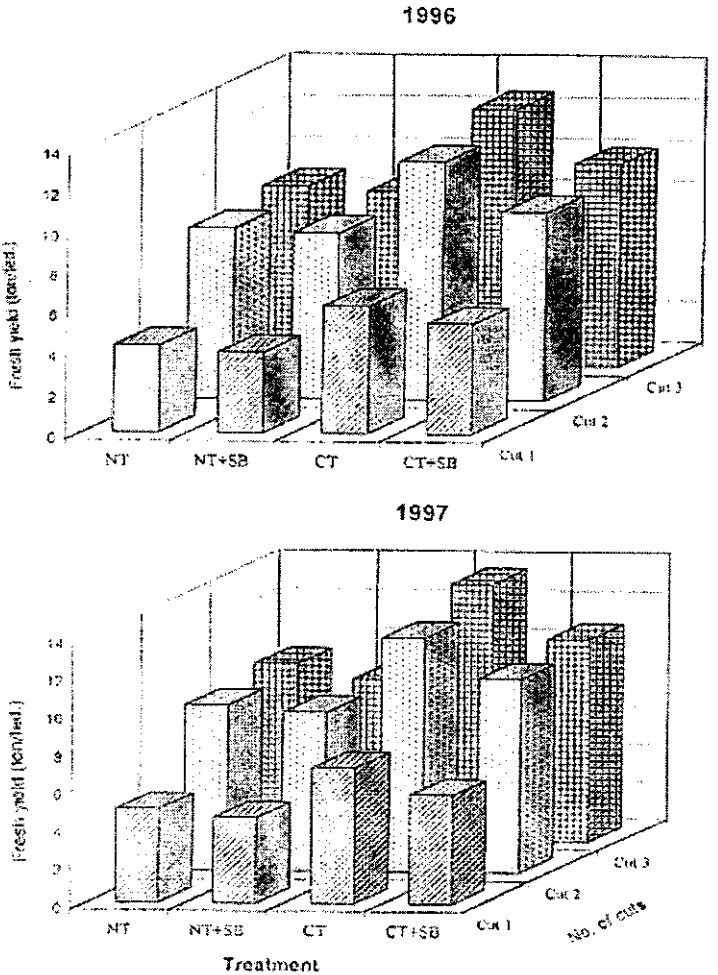

Fig. 2. Fresh yield of berseem at different cuts as influenced by the investigated treatments of rice stubble management.

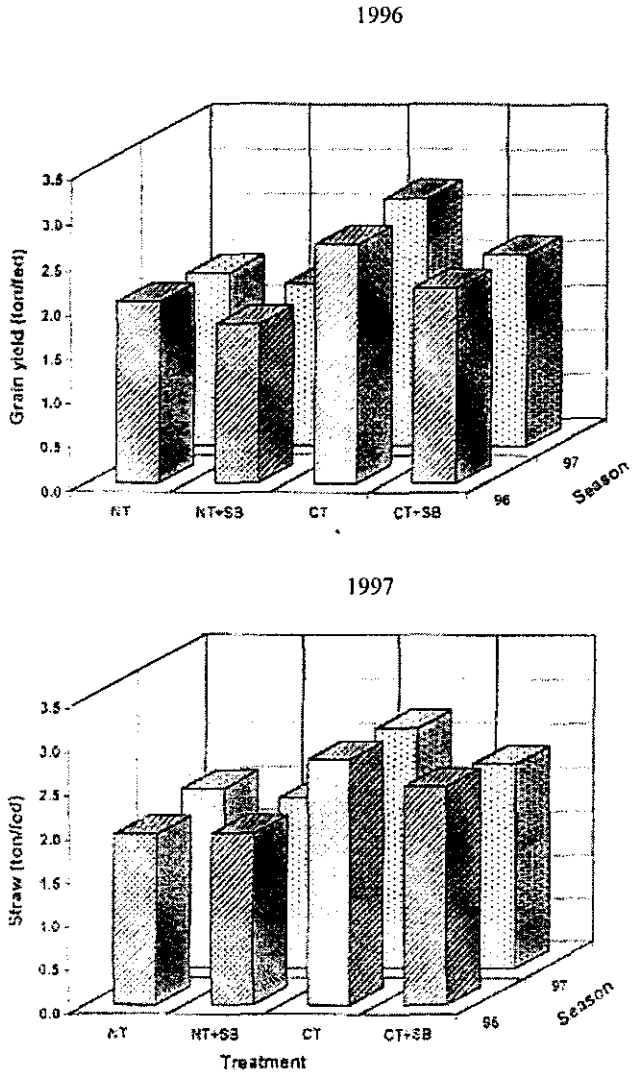

Fig. 3. Grain and straw yields of rice as influenced by the investigated treatment of rice stubble management.

The increase in fresh yield of berseem under (CT) treatment may be due to the improvement of soil physical, chemical and biological properties as well as increasing the availability of soil macro nutrients for plant (Data under publication). This improvement is considered a sequence to tillage practice (plowing) which encourage root development and penetration, and provide an optimum air-water balances, maximum water storage capacity and moderate gas exchange for the best plant growth.

Economic evaluation

The profit to cost ratio (P/C) of the mean yield and the economic classes (orders) are shown in Tables 2, 3 and 4. The data show that conventional tillage (CT) treatment gave the highest profit for both crops (berseem and rice) followed by conventional tillage + stubble burning (CT + SB) treatment. The absolute profit took the following order:

(CT) > (CT + SB) > (NT) > (NT + SB) for both crops (berseem and rice) during the two seasons.

The total net farm income resulted from (CT) treatment was approximately ≈ L.E. 1100/year/fed. In contrast the loss in the net farm income under (NT + SB) treatment was found to be ≈ L.E. 220/year/fed. Furthermore, in Egypt, 1.2 millions fed of the land is used to grow rice crop, each fed. produce ≈ 3 tonnes of straw and normally burned. So, the resulting reduction in the total national income is about L.E. 144 millions yearly.

In conclusion, it is recommended not to burn rice stubble but rather incorporate it into the soil in order to increase its organic matter content. Organic matter increases soil fertility e specially for nitrogen and improves soil physical properties which is strongly requested to provide good sustainability for profitable cultivation. On the other hand, if it is necessary to burn rice stubble in the field, it is recommended to plow the soil directly after burning, this may overshadow the opposite effect of the burning practice.

As well, the direct negative effects of rice stubble burning on the yield of subsequent crops, burning cereal stubbles proved to be the most essential source for air pollution by the resulting smokes (Plate 1).

TABLE 2. The fresh yield of berseem crop and profit to cost ratio (P/C) as affected by rice stubble management.

Treatment	Season	Cost (L.E.)	Total Yield (t/fed)	No. of Cuts	Price For 1 cut (L.E.)	Total Income (L.E.)	Profit (L.E.)	Profit/ Cost Ratio	Total Income/ cost ratio	Order
NT	1996	270.30	21.54 C*	3	500	1500.00	1229.70	4.55	5.55	2
NT + SB		270.30	20.77 C	3	500	1446.45	1176.15	4.35	5.35	3
CT		362.80	30.63 A	3	500	2133.00	1770.20	4.88	5.88	1
CT + SB		362.80	24.73 B	3	500	1722.00	1359.20	3.75	4.75	4
LSD at 0.05			2.494							
NT	1997	275.00	23.15 C	3	560	1680.00	1405.00	5.11	6.11	2
NT + SB		275.00	21.31 C	3	560	1546.44	1271.44	4.62	5.62	3
CT		379.70	33.19 A	3	560	2408.45	2028.75	5.34	6.34	1
ST + SB		379.70	26.96 B	3	560	1956.36	1576.66	4.15	5.15	4
LSD at 0.05			2.518							

* Means with the same letter are not significantly different.

TABLE 3. The grain and straw yields of rice crop and Profit to cost ratio (P/C) as affected by rice stubble management.

Treatment	Season	Cost (L.E.)	Grain		Straw		Total income (L.E.)	Profit (L.E.)	Profit/ Cost Ratio	Total Income/ cost ratio	Order
			(t/fed)	Price (for ton) (L.E.)	(t/fed)	Price (for ton) (L.E.)					
NT	1996	1012.0	2.05 B*	680	2.30 B	34	1472.20	460.20	0.45	1.45	3
NT + SB		1012.0	1.80 B	680	2.28 B	34	1301.52	289.52	0.29	1.29	4
CT		1012.0	2.69 A	680	2.98 A	34	1930.52	918.52	0.91	1.91	1
CT + SB		1012.0	2.21 AB	680	2.72 AB	34	1595.28	583.28	0.58	1.58	2
LSD at 0.05			0.513		0.560						
NT	1997	1096.7	1.95 C	695	2.38 B	40	1450.45	353.75	0.32	1.32	3
NT + SB		1096.7	1.84 C	695	2.24 B	40	1368.40	271.70	0.25	1.25	4
CT		1096.7	2.77 A	695	3.01 A	40	2045.55	948.85	0.86	1.87	1
ST + SB		1096.7	2.16 B	695	2.48 B	40	1600.2	503.50	0.46	1.46	2
LSD at 0.05			0.137		0.255						

* Means with the some letter are not significantly different.

TABLE 4. Total Profit to total cost ratio (P/C) (rice + berseem crops) .

Treatment	Season	Cost (L.E.)			Total income (L.E.)			Profit (L.E.)	Profit/ Cost ratio	Total Income/ cost ratio	Order
		Rice	Berseem	Total	Rice	Berseem	Total				
NT	1996	1012.00	270.30	1282.30	1472.20	1500.00	2972.20	1689.90	1.32	2.32	3
NT + SB		1012.00	270.30	1282.30	1301.52	1446.45	2747.97	1465.67	1.14	2.14	4
CT		1012.00	362.80	1374.80	1930.52	2133.00	4063.52	2688.72	1.96	2.96	1
CT + SB		1012.00	362.80	1374.80	1595.28	1722.00	3317.28	1942.48	1.41	2.41	2
NT	1997	1096.70	275.00	1371.70	1450.45	1680.00	3130.45	1758.75	1.28	2.28	3
NT + SB		1096.70	275.00	1371.70	1368.40	1546.44	2914.84	1543.14	1.13	2.13	4
CT		1096.70	379.70	1476.40	2045.55	2408.45	4454.00	2977.6	2.02	3.02	1
ST + SB		1096.70	379.70	1476.40	1600.20	1956.36	3556.56	2080.16	1.41	2.41	2

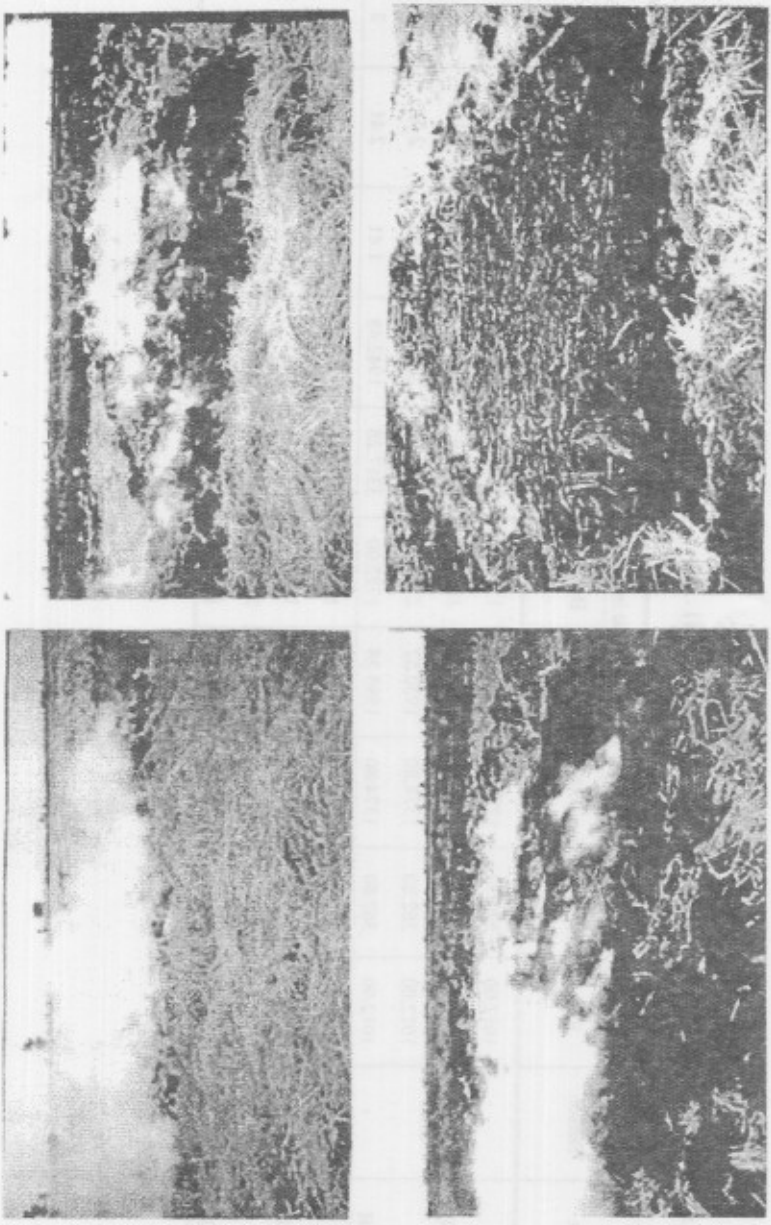

Plate 1. Air pollution by a smoke emission due to stubble burning of rice.

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تقييم إقتصادى لتأثير بعض طـرق تـدوير مخلفـات الأرز علـى محصولى البرسيم والأرز

رجاء عليوه أحمد صبره ، يحيى عرفه ، شفيق إبراهيم عبد العال و محسن عبد الحميـد البسيونـى*
قسم الأراضى – كلية الزراعة – جامعة القاهرة و* معهد بحوث الأراضى والمياه والبيئة – القاهرة – مصر .

تعتبر عملية تدوير مخلفات المحاصيل عامل هام فـى وضع إستراتيجية التخلص منهـا وذلك لما لها من علاقة واضحة بنوعية المحصول النامى ، تتـابع المحاصـيل فـى الـدورة الزراعية ، كميات الأسمدة والمبيـدات اللازمـة بالإضـافة إلـى علاقتهـا الواضحـة بإنتاجيـة المحاصيل المتتابعة. لذلك أختبرت أربعة طرق لتدوير مخلفـات الأرز (بدون خدمة (NT) ، بدون خدمة + حرق (NT + SB) ، خدمة تقليديـة مـع قلب مخلفات الأرز (CT) وحـرق + خدمة تقليدية (CT + SB) لتقييم تأثيرهـا علـى محصولى البرسيم الطـازج (*Trifolium alexandrinum*) والأرز (*Oriza sativa*) المنزرع فى تربة طينية بمحطة التجارب الزراعية بسخا ، منطقة تانى النطاف ، محافظة كفر الشيخ – مصر لمدة موسمين متتاليين.

أظهرت النتائج أن محصول البرسيم الطازج قد تأثر معنويا بالمعـاملات التجريبيـة المختبرة ، فمقارنة بمعاملة بدون الخدمة (NT) = control أعطت معاملة الخدمة التقليدية (CT) زيادة تتراوح بين ٤٢,٢٪ إلى ٤٣,٤٪ بينما أعطت معاملة حرق المخلفات (NT + SB) إنخفاضاً معنوياً تراوح بين ٣,٦ إلـى – ٧,٩٪.

أظهرت النتائج أيضا أن محصولى الأرز من الحبوب والقش قد اسـتجاب إسـتجابة معنوية لمعاملة الخدمة التقليدية (CT) حيث زاد محصـول الحبـوب بحـوالى ٣١,٢٪ ، ٤٢,١٪ والقش ٢٩,٠ ، ٢٦,٥ ٪ فى الموسمين على التوالى.

دل التقييم الإقتصادى لمحصولى البرسيم والأرز أن معاملة الخدمة التقليديـة (CT) أعطت أكبر عائد إقتصادى تلاها معاملة الحرق + الخدمة التقليدية (CT + SB) ، بينمـا أعطت معاملـة الحرق (NT + SB) أكـبر فاقـد فـى ناتـج الدخـل الكلـى (Total farm income) مقارنة بمعاملة بدون خدمة (NT) . هذا بالإضافة إلى المردود البيئـى السلبى الناتج عن تلوث الهواء.